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Fukuda et al.

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(54) **AUTONOMOUS TRAVEL WORK SYSTEM**

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G05D 1/02	(2006.01)
A01B 69/04	(2006.01)

(Continued)

(52) **U.S. Cl.**

CPC ***A01D 34/008*** (2013.01); ***A01B 69/00*** (2013.01); ***A01B 69/008*** (2013.01); ***A01D 34/64*** (2013.01); ***G05D 1/00*** (2013.01); ***G05D 1/02*** (2013.01); ***G05D 1/0274*** (2013.01); ***G05D 1/0278*** (2013.01); ***G06F 3/04845*** (2013.01); ***G06F 3/04847*** (2013.01); ***G06Q 10/0631*** (2013.01); ***G06Q 30/0283*** (2013.01); *G05D 2201/0208* (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

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Primary Examiner — Thomas Tarcza
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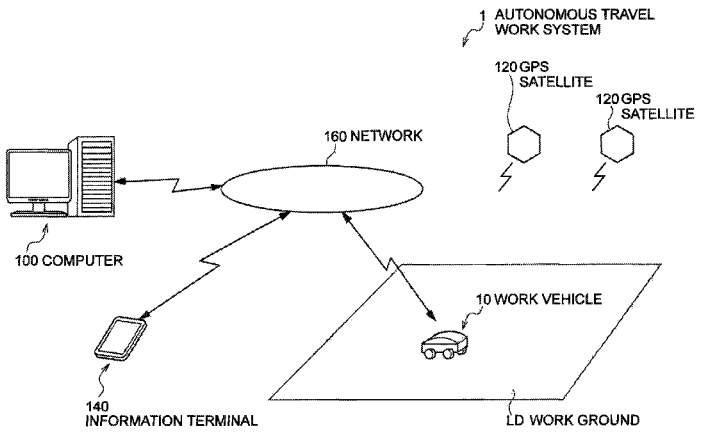
(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

An autonomous travel work system works, regarding a garden LD as a canvas and applying an arbitrary design to the garden LD, according the design. The autonomous travel work system includes an information terminal configured to be input means and transmit input information, a computer configured to receive the input information, and at least one electric lawn mower configured to work autonomously traveling in the garden LD. The information terminal includes a display, a work ground input, a design allocation input, and a work request device. The information terminal or the computer includes a work ground designation device, a design allocation device, a mapping route generator, and a work pattern generator.

20 Claims, 19 Drawing Sheets



(51) **Int. Cl.**

A01B 69/00	(2006.01)
A01D 34/64	(2006.01)
G05D 1/00	(2006.01)
G06F 3/0484	(2013.01)
G06Q 10/06	(2012.01)
G06Q 30/02	(2012.01)

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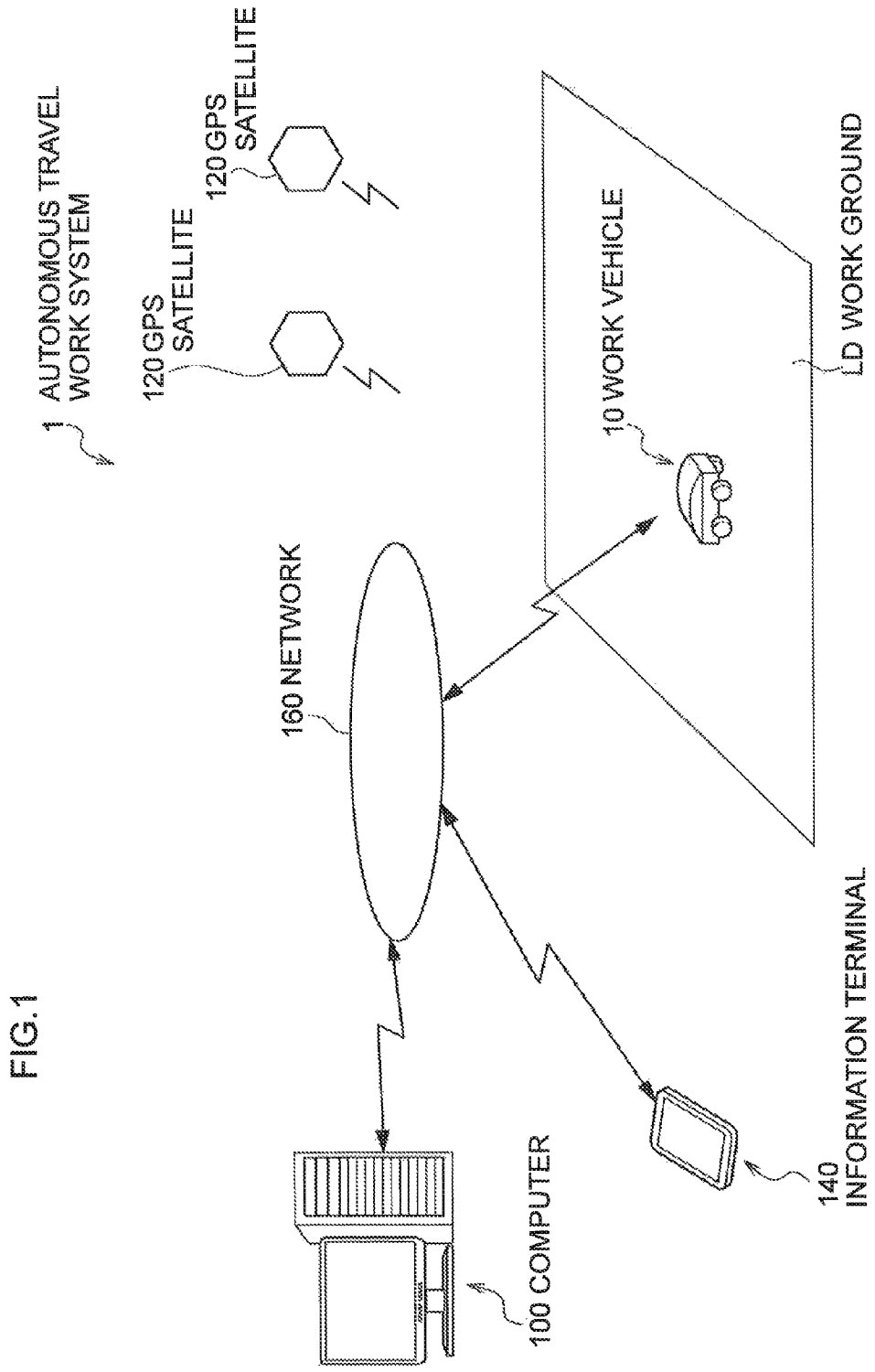

1 AUTONOMOUS TRAVEL WORK SYSTEM
120 GPS SATELLITE
120 GPS SATELLITE
10 WORK VEHICLE
LD WORK GROUND
160 NETWORK
100 COMPUTER
140 INFORMATION TERMINAL

FIG.1

FIG.2

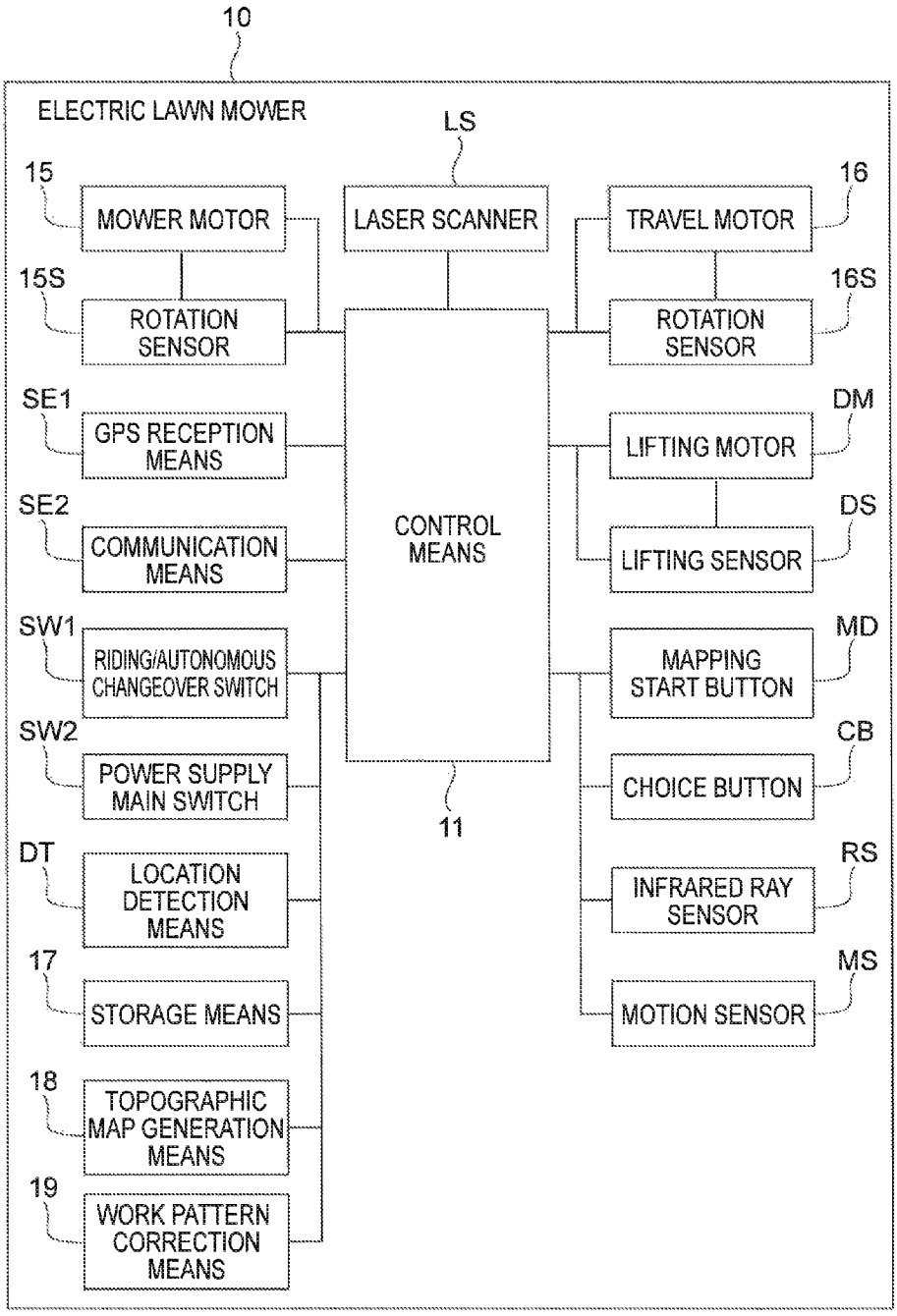

10
ELECTRIC LAWN MOWER
LS
15
MOWER MOTOR
LASER SCANNER
TRAVEL MOTOR
16
15S
ROTATION SENSOR
ROTATION SENSOR
16S
SE1
GPS RECEPTION MEANS
LIFTING MOTOR
DM
SE2
COMMUNICATION MEANS
CONTROL MEANS
LIFTING SENSOR
DS
SW1
RIDING/AUTONOMOUS CHANGEOVER SWITCH
MAPPING START BUTTON
MD
SW2
POWER SUPPLY MAIN SWITCH
CHOICE BUTTON
CB
11
DT
LOCATION DETECTION MEANS
INFRARED RAY SENSOR
RS
17
STORAGE MEANS
MOTION SENSOR
MS
18
TOPOGRAPHIC MAP GENERATION MEANS
19
WORK PATTERN CORRECTION MEANS

FIG.3

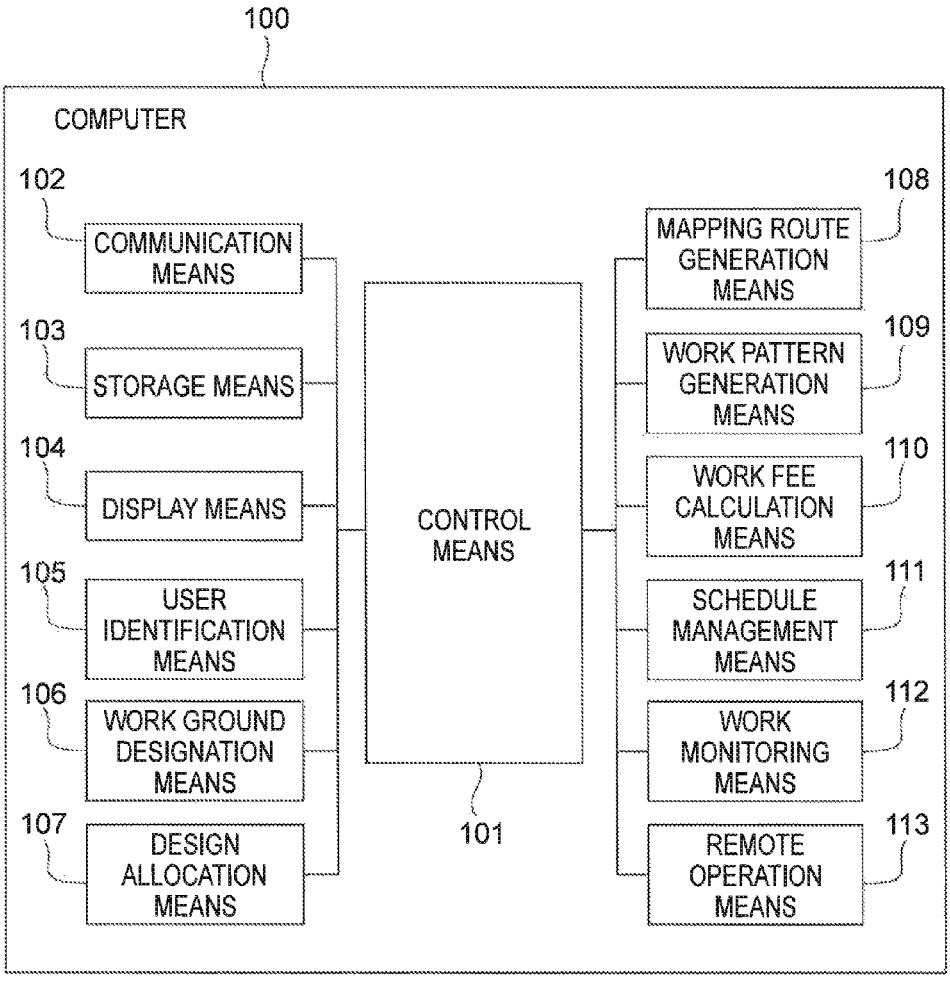

100
COMPUTER
102
COMMUNICATION MEANS
103
STORAGE MEANS
104
DISPLAY MEANS
105
USER IDENTIFICATION MEANS
106
WORK GROUND DESIGNATION MEANS
107
DESIGN ALLOCATION MEANS
CONTROL MEANS
101
108
MAPPING ROUTE GENERATION MEANS
109
WORK PATTERN GENERATION MEANS
110
WORK FEE CALCULATION MEANS
111
SCHEDULE MANAGEMENT MEANS
112
WORK MONITORING MEANS
113
REMOTE OPERATION MEANS

FIG.4

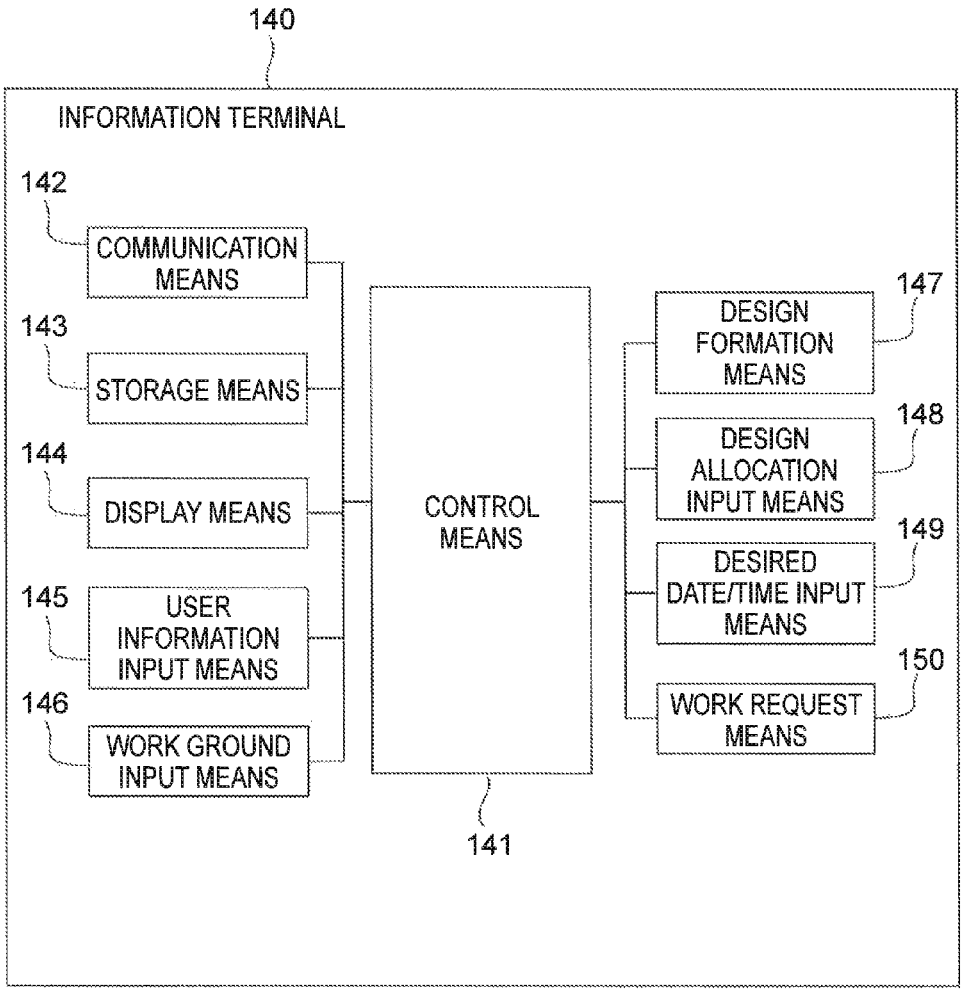

140
INFORMATION TERMINAL
142
COMMUNICATION MEANS
143
STORAGE MEANS
144
DISPLAY MEANS
145
USER INFORMATION INPUT MEANS
146
WORK GROUND INPUT MEANS
CONTROL MEANS
141
147
DESIGN FORMATION MEANS
148
DESIGN ALLOCATION INPUT MEANS
149
DESIRED DATE/TIME INPUT MEANS
150
WORK REQUEST MEANS

FIG.5

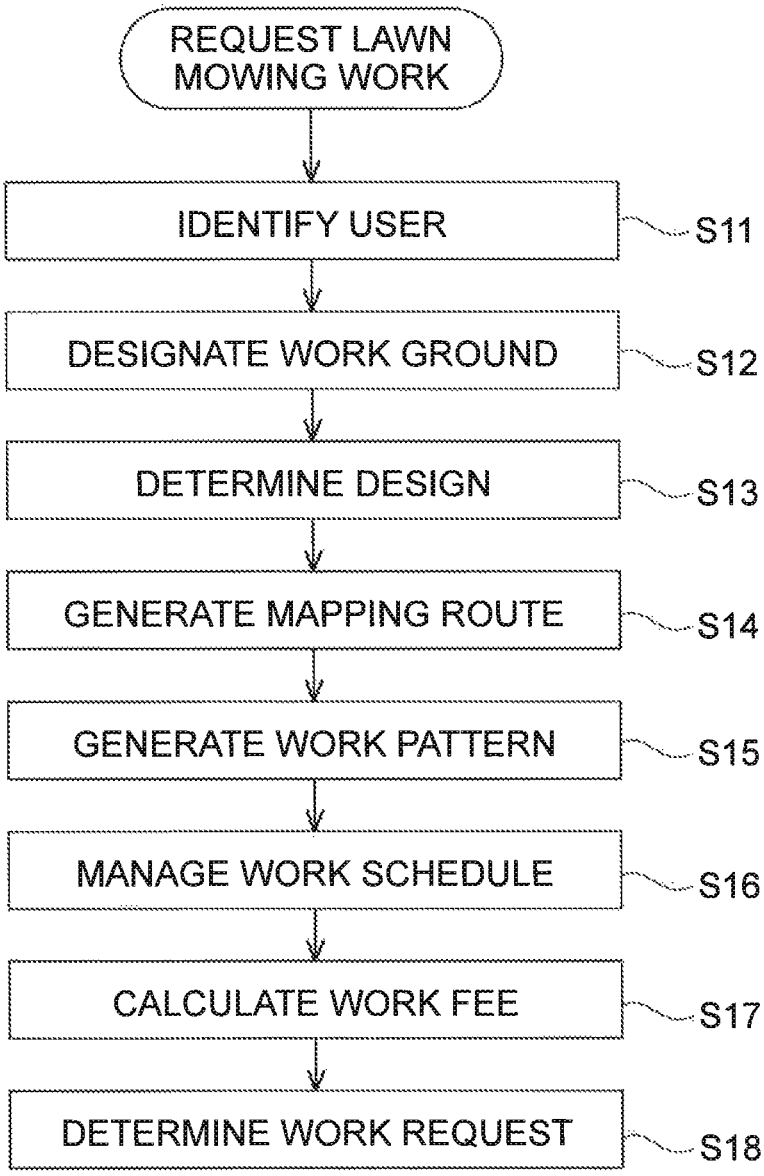

REQUEST LAWN MOWING WORK
IDENTIFY USER
S11
DESIGNATE WORK GROUND
S12
DETERMINE DESIGN
S13
GENERATE MAPPING ROUTE
S14
GENERATE WORK PATTERN
S15
MANAGE WORK SCHEDULE
S16
CALCULATE WORK FEE
S17
DETERMINE WORK REQUEST
S18

FIG.6

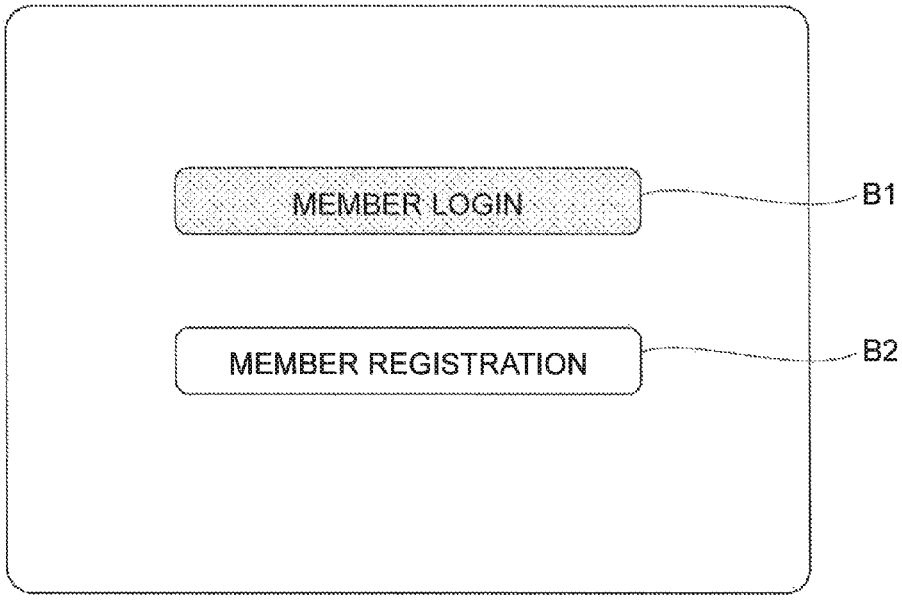


FIG.7

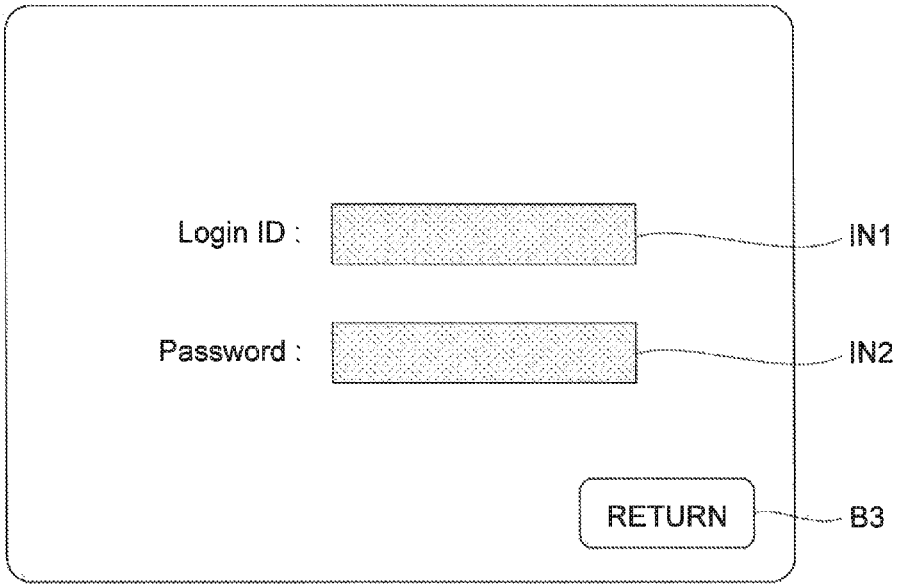


FIG.8

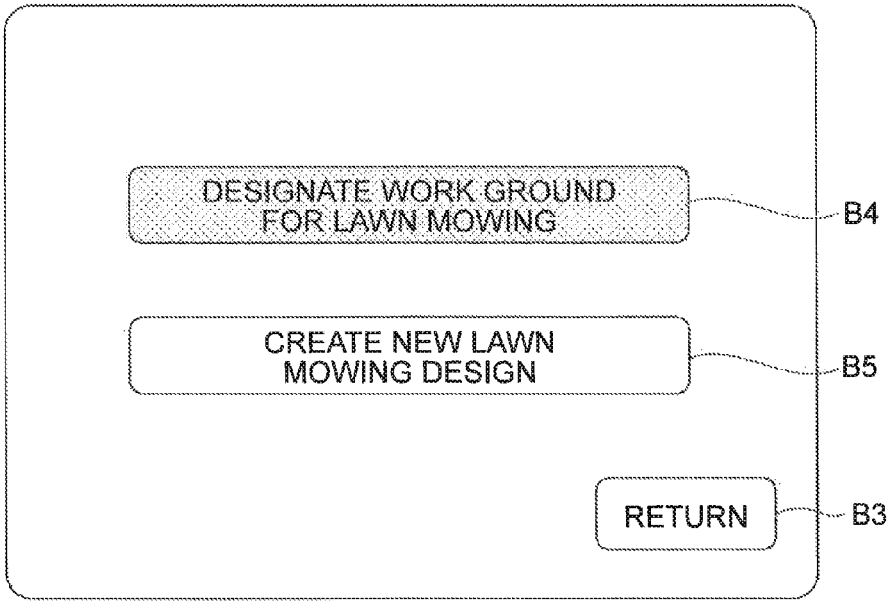

DESIGNATE WORK GROUND FOR LAWN MOWING
B4
CREATE NEW LAWN MOWING DESIGN
B5
RETURN
B3

FIG.9

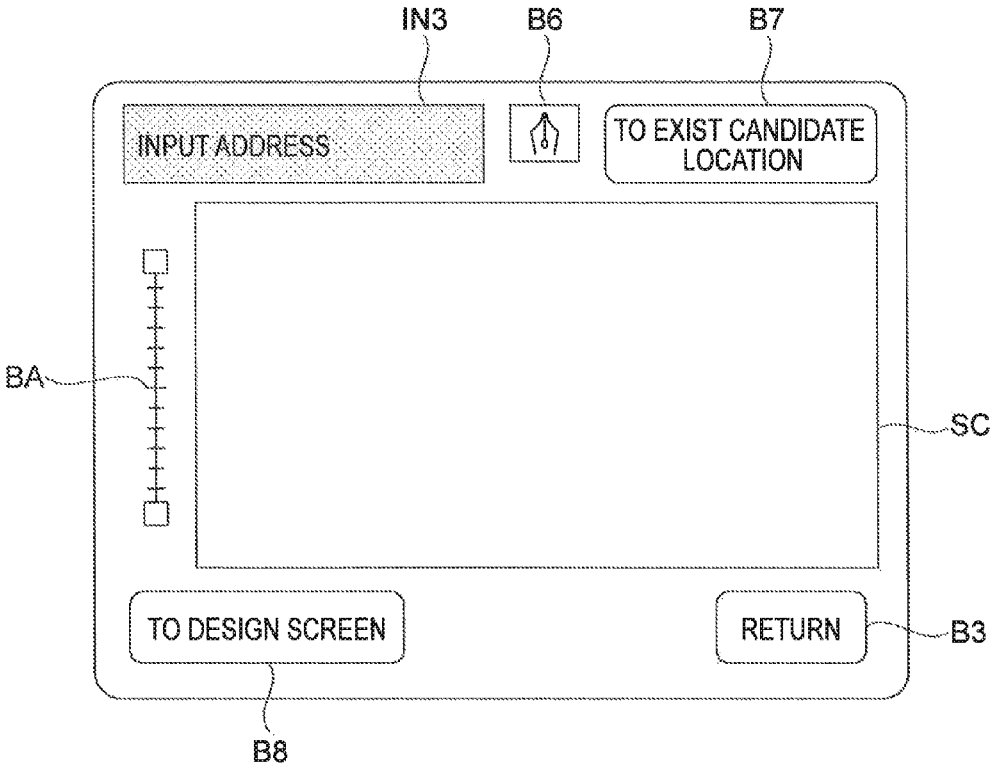

IN3
B6
B7
INPUT ADDRESS
TO EXIST CANDIDATE LOCATION
BA
SC
TO DESIGN SCREEN
RETURN
B3
B8

FIG.10

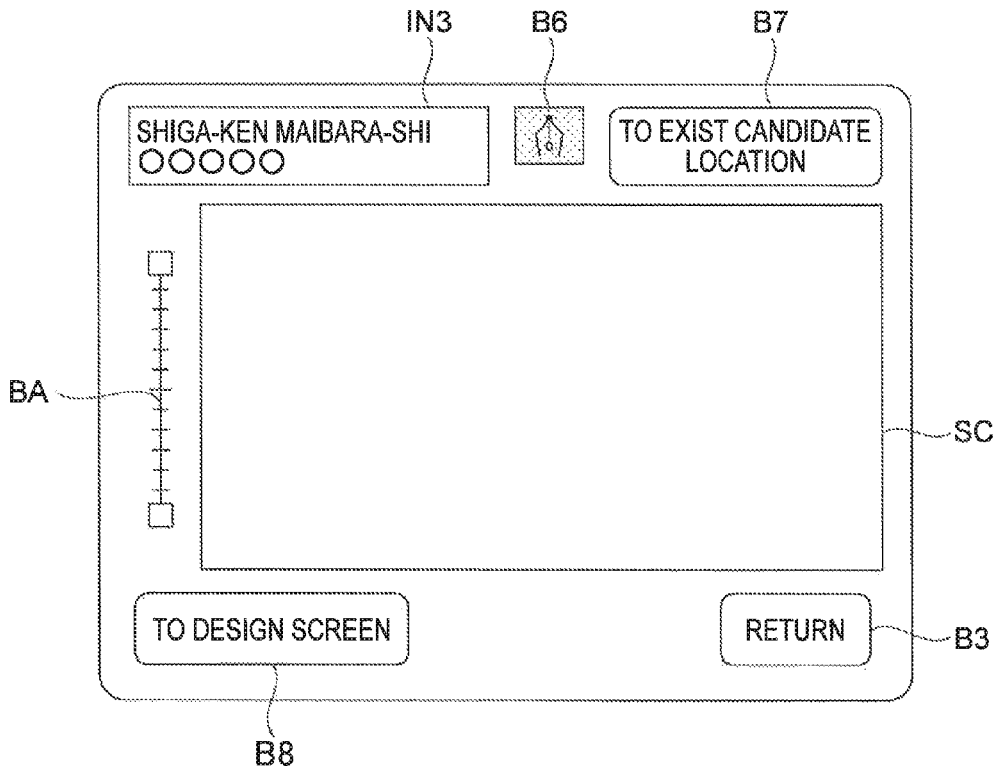

IN3
B6
B7
SHIGA-KEN MAIBARA-SHI
TO EXIST CANDIDATE LOCATION
BA
SC
TO DESIGN SCREEN
RETURN
B3
B8

FIG.11

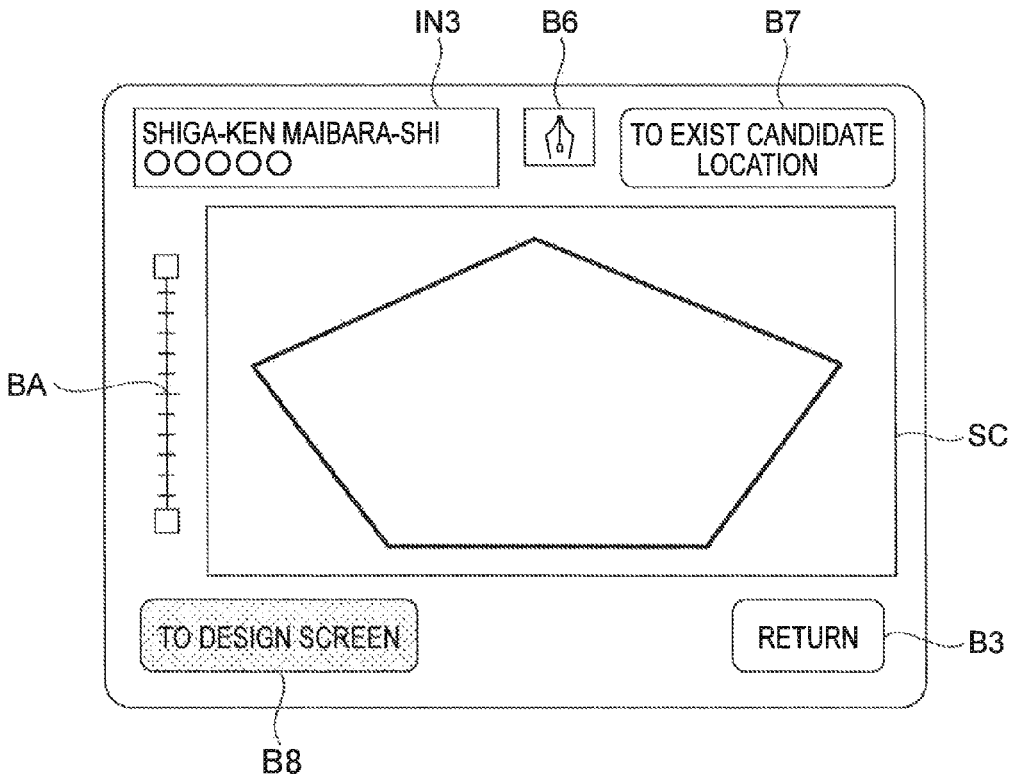

IN3
B6
B7
SHIGA-KEN MAIBARA-SHI
OOOOO
TO EXIST CANDIDATE LOCATION
BA
SC
TO DESIGN SCREEN
RETURN
B3
B8

FIG.12

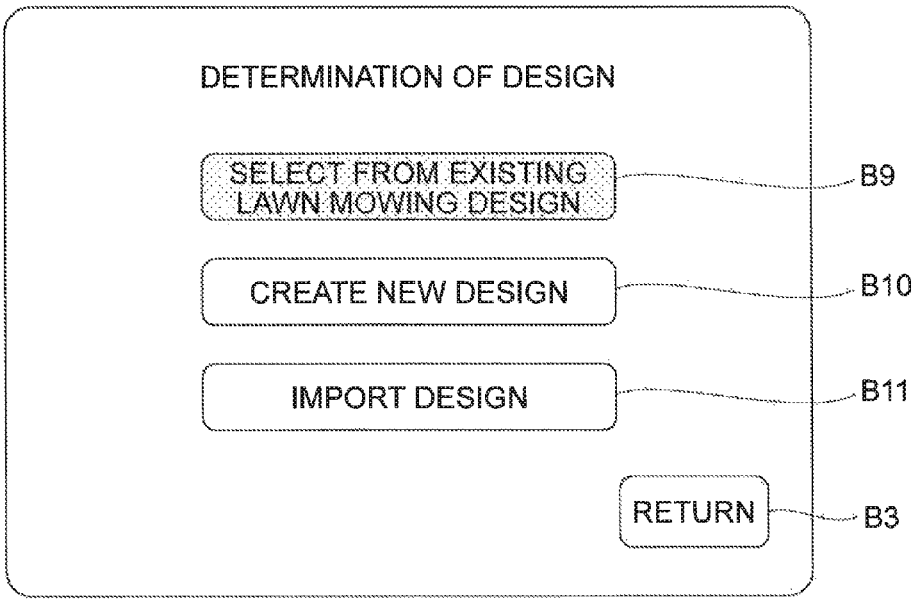

DETERMINATION OF DESIGN
SELECT FROM EXISTING LAWN MOWING DESIGN
B9
CREATE NEW DESIGN
B10
IMPORT DESIGN
B11
RETURN
B3

FIG.13

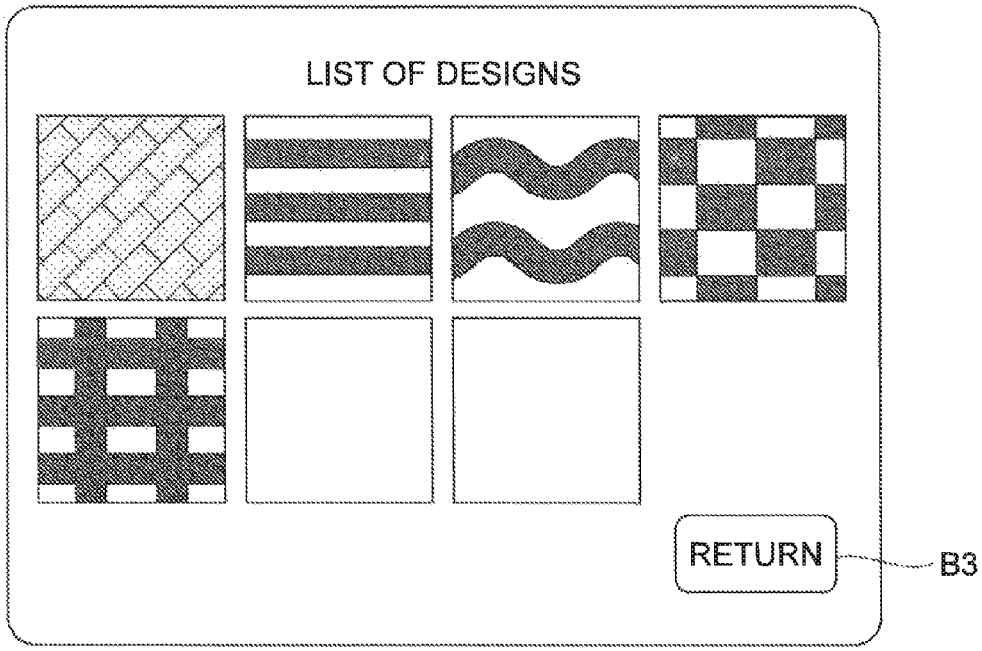


FIG.14

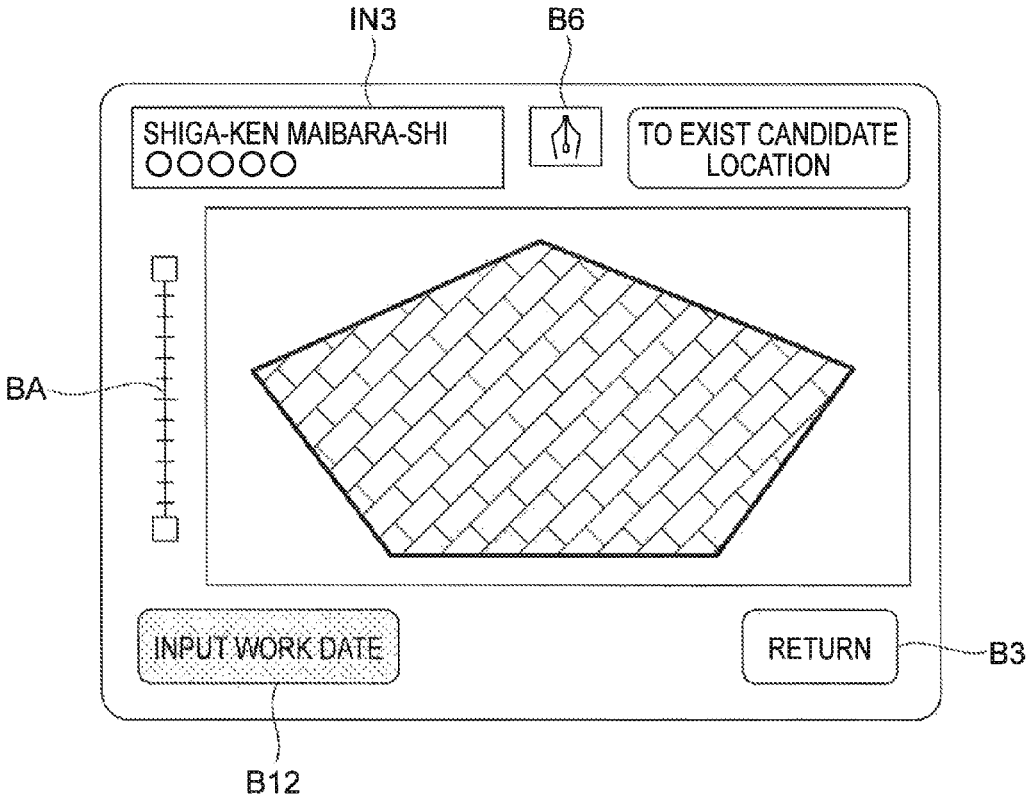

IN3
B6
SHIGA-KEN MAIBARA-SHI
TO EXIST CANDIDATE LOCATION
BA
INPUT WORK DATE
RETURN
B3
B12

FIG.15

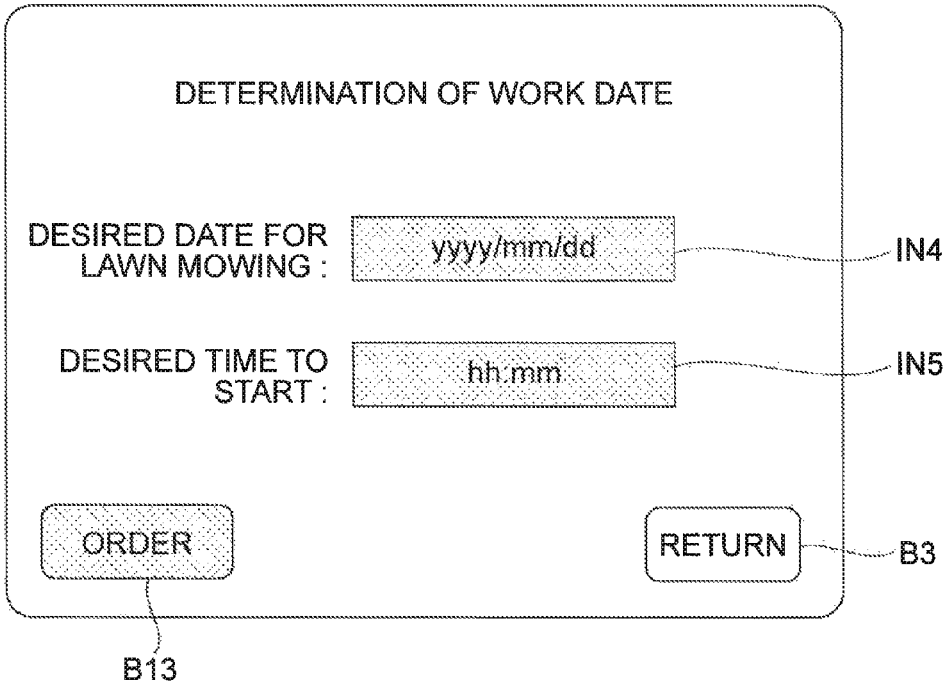

DETERMINATION OF WORK DATE
DESIRED DATE FOR LAWN MOWING :
yyyy/mm/dd
IN4
DESIRED TIME TO START :
hh:mm
IN5
ORDER
RETURN
B3
B13

FIG.16

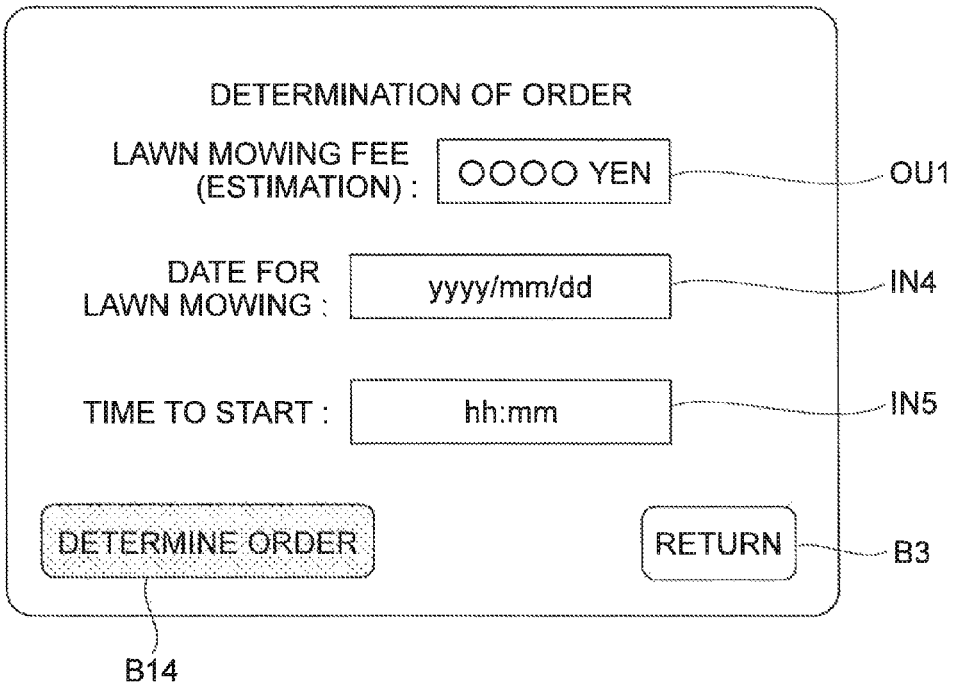

DETERMINATION OF ORDER
LAWN MOWING FEE (ESTIMATION) :
OOOO YEN
OU1
DATE FOR LAWN MOWING :
yyyy/mm/dd
IN4
TIME TO START :
hh:mm
IN5
DETERMINE ORDER
RETURN
B3
B14

FIG.17

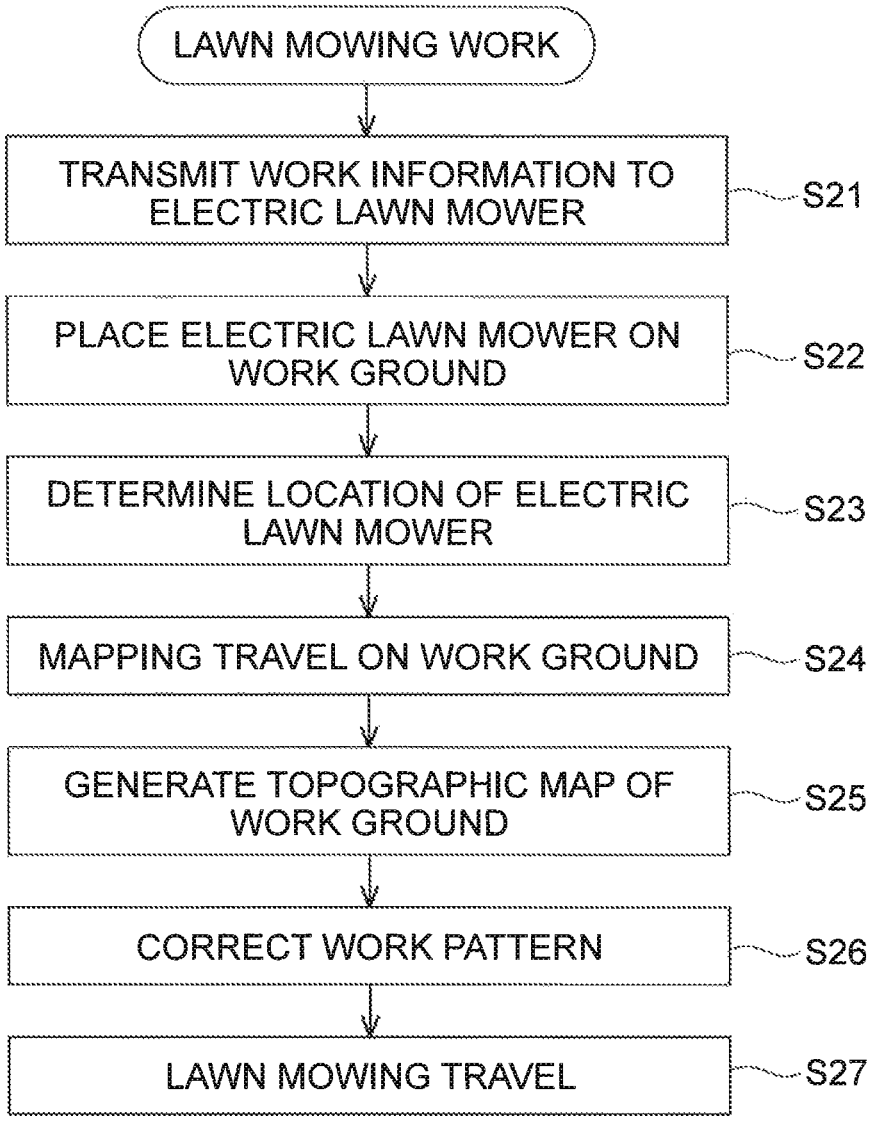

LAWN MOWING WORK
TRANSMIT WORK INFORMATION TO ELECTRIC LAWN MOWER
S21
PLACE ELECTRIC LAWN MOWER ON WORK GROUND
S22
DETERMINE LOCATION OF ELECTRIC LAWN MOWER
S23
MAPPING TRAVEL ON WORK GROUND
S24
GENERATE TOPOGRAPHIC MAP OF WORK GROUND
S25
CORRECT WORK PATTERN
S26
LAWN MOWING TRAVEL
S27

FIG.18

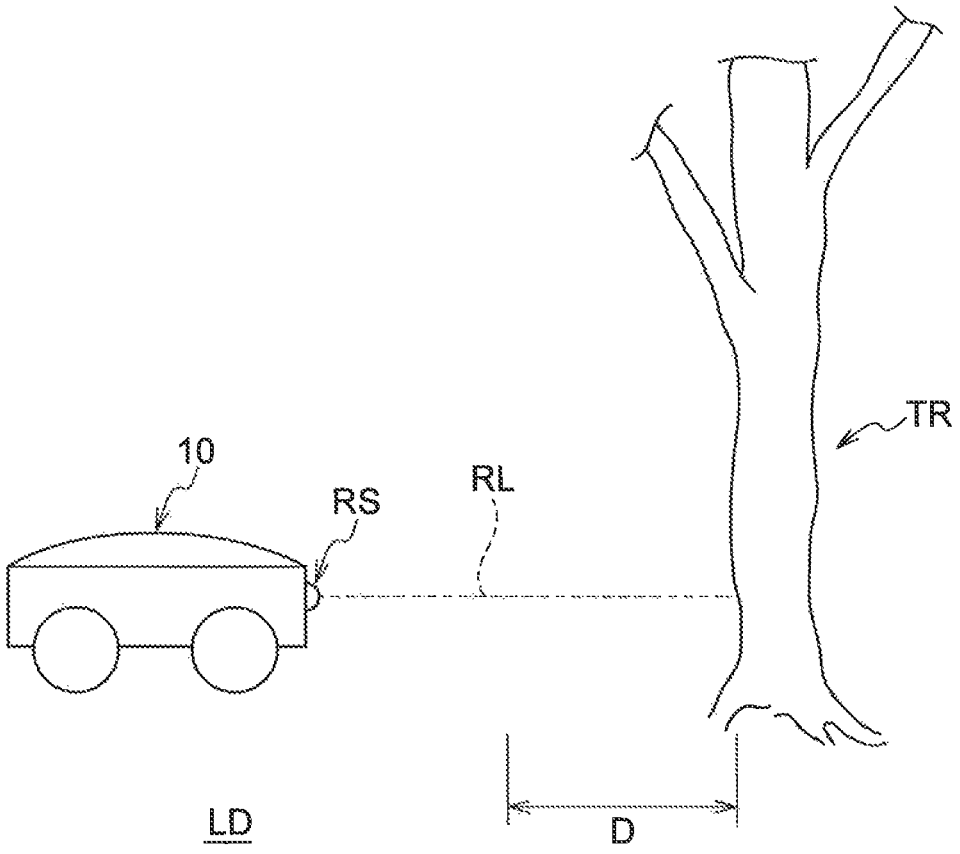
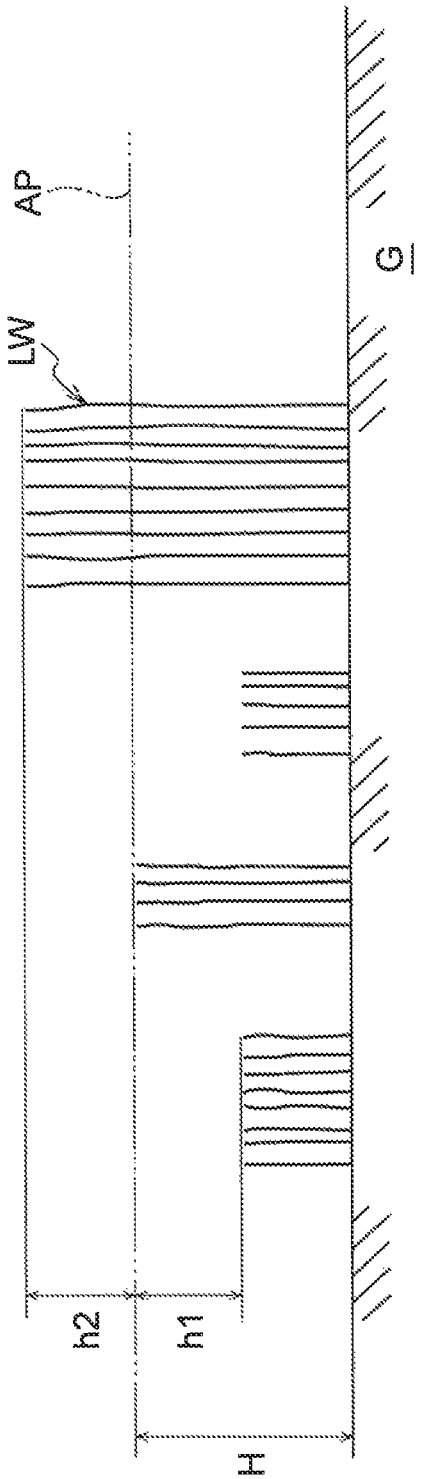


FIG. 19



AUTONOMOUS TRAVEL WORK SYSTEM

TECHNICAL FIELD

The present invention relates to an autonomous travel work system which works, regarding a work ground as a canvas and applying an arbitrary design to the work ground, according to the design.

BACKGROUND ART

Patent Literature 1 discloses an example of an autonomous travel work system using an electric lawn mower which autonomously travels using a GPS radio wave signal from a GPS satellite. The literature discloses a system which can mow a lawn autonomously traveling by performing radio communication between a base station and an electric lawn mower.

CITATION LIST

Patent Literature

Patent Literature 1: JP 2012-105557 A

SUMMARY OF INVENTION

Technical Problem

When a lawn in a relatively large garden is mowed, there is a request to draw a design, such as an image and a letter, regarding the lawn as a canvas. In this case, it is required to mow the lawn after applying the design, such as an image and a letter, to a shape of the garden. However, a method for applying a design, such as an image and a letter, to a garden, and a system, in which a system user requests to mow a lawn according to the design, and the execution and the management of the requested lawn mowing are performed, has not been constructed. Therefore, the invention provides an autonomous travel work system which works, regarding a work ground as a canvas and applying an arbitrary design to the work ground, according to the design.

Solution to Problem

Therefore, the invention described in claim **1** is an autonomous travel work system which works, regarding a work ground as a canvas and applying an arbitrary design to the work ground, according to the design, the system including:

an information terminal configured to be input means and transmit input information;

a computer configured to receive the input information; and

at least one work vehicle configured to work autonomously traveling in the work ground, wherein

the information terminal includes:

display means for displaying a map image including the work ground;

work ground input means for inputting the work ground on the map image displayed on the display unit;

design allocation input means for inputting the arbitrary design to be allocated to the work ground; and

work request means for requesting a work,

the information terminal or the computer includes:

work ground designation means for generating location information about the work ground based on the work ground input on the map image;

design allocation means for allocating the input design to the work ground and generating location information about the design and contrast information about the design; and

work information generation means for generating geographical information about the work ground designated on the map image and the input design as work information.

The invention described in claim **2** is, in the autonomous travel work system according to claim **1**, the information terminal includes design generation means for creating the design.

The invention described in claim **3** is, in the autonomous travel work system according to claim **1** or **2**, the information terminal or the computer includes the work fee calculation means for calculating a work fee estimation based on the work information,

the information terminal includes desired date/time input means for inputting a desired date and time for the work, and

the computer includes schedule management means for managing a schedule of the work based on the desired date and time.

The invention described in claim **4** is, in the autonomous travel work system according to any of claims **1** to **3**, the design allocation means sets the design based on constraint conditions on that the work vehicle is able to work.

The invention described in claim **5** is, in the autonomous travel work system according to any of claims **1** to **4**, the information terminal or the computer includes design extracting means for extracting a recommended design suitable for a shape of the work ground from existing designs.

The invention described in claim **6** is, in the autonomous travel work system according to any of claims **1** to **5**, the information terminal or the computer includes storage means for storing the work information, and

the work request means included in the information terminal requests the work based on the work information.

The invention described in claim **7** is, in the autonomous travel work system according to any of claims **1** to **6**, the work request means performs settlement of the work fee when the work is requested.

The invention described in claim **8** is, in the autonomous travel work system according to any of claims **1** to **7**, the computer is movable.

The invention described in claim **9** is, in the autonomous travel work system according to any of claims **1** to **8**, the work is a grass mowing work.

The invention described in claim **10** is, in the autonomous travel work system according to any of claims **1** to **9**, the work vehicle electrically travels and works.

Advantageous Effects of Invention

According to the invention described in claim **1**, an autonomous travel work system works, regarding a work ground as a canvas and applying an arbitrary design to the work ground, according to the design. The autonomous travel work system includes an information terminal configured to be input means and transmit input information, a computer configured to receive the input information, and at least one work vehicle configured to work autonomously traveling in the work ground. The information terminal includes display means for displaying a map image including the work ground, work ground input means for inputting the work ground on the map image displayed on the display unit, design allocation input means for inputting an arbitrary design to be allocated to the work ground, and work request means for requesting the

work. The information terminal or the computer includes work ground designation means for generating location information about the work ground based on the work ground input on the map image, design allocation means for allocating the input design to the work ground and generating location information about the design and contrast information about the design, and work information generation means for generating geographical information about the work ground designated on the map image and work information about the input design.

Therefore, there can be provided an autonomous travel work system which can work, regarding a work ground as a canvas and applying an arbitrary design to the work ground, according to the design. Furthermore, a system user can easily request a work. For example, when a lawn in a relatively large garden is mowed, it is thereby possible to draw a design, such as an image and a letter, regarding the lawn as a canvas with an easy request method.

According to the invention described in claim **2**, the information terminal includes design creation means for creating the design. Therefore, the system user can arbitrarily create a desired design.

According to the invention described in claim **3**, the information terminal or the computer includes work fee calculation means for calculating a work fee estimation based on the work information. The information terminal includes desired date/time input means for inputting a desired date and time for the work, and the computer includes schedule management means for managing a schedule of the work based on the desired date and time. Therefore, the system user can review or change the work contents and decide whether the user requests the work or not based on the work fee estimation. The work can be performed on the system user's desired date and time, and the work schedule can be managed.

According to the invention described in claim **4**, the design allocation means sets the design based on constraint conditions on that the work vehicle is able to work. Therefore, when the system user creates a design, the user is not required to confirm whether the work vehicle can work based on the design or not. Since the design based on which the work vehicle can work is set, the system user can grasp how the work is performed based on the created design before requesting the work. The system user can thereby easily request the work.

According to the invention described in claim **5**, the information terminal or the computer includes design extraction means for extracting a recommended design suitable for a shape of the work ground from existing designs. Therefore, the means assists the system user in creating a design and it is possible to reduce the system user's labor for creating a design.

According to the invention described in claim **6**, the information terminal or the computer includes storage means for storing the work information, and the work request means included in the information terminal requests the work based on the work information. Once the work information is generated, the information does not need to be regenerated, and it is possible to reduce the system user's labor for requesting the work. The system user can thereby easily request the work.

According to the invention described in claim **7**, when the work is requested, the work request means performs settlement of the work fee. Therefore, the system user and the system provider can easily perform the settlement.

According to the invention described in claim **8**, the computer is movable. Therefore, by placing the computer near the work ground, monitoring the movement of the work vehicle with the computer, the actual movement of the work vehicle can be visually observed. More reliable work can be thereby performed.

According to the invention described in claim **9**, the work is a grass mowing work. Therefore, lawn mowing can be performed according to an arbitrary design on a lawn in a golf course, a large garden, and the like.

According to the invention described in claim **10**, the work vehicle electrically travels and works. Therefore, exhaust gas is not emitted unlike an engine driven vehicle, and it is beneficial to prevent atmospheric pollution and global warming.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a diagram to illustrate an example of an autonomous travel work system of the invention.

FIG. **2** is a block diagram showing a configuration of an electric lawn mower as a constituent element of it.

FIG. **3** is a block diagram showing a configuration of a computer as a constituent element of it.

FIG. **4** is a block diagram showing a configuration of an information terminal as a constituent element of it.

FIG. **5** is a flowchart of a lawn mowing work request by the autonomous travel work system.

FIG. **6** is an example of a screen to input request information to the system.

FIG. **7** is an example of a screen to input request information to the system.

FIG. **8** is an example of a screen to input request information to the system.

FIG. **9** is an example of a screen to input request information to the system.

FIG. **10** is an example of a screen to input request information to the system.

FIG. **11** is an example of a screen to input request information to the system.

FIG. **12** is an example of a screen to input request information to the system.

FIG. **13** is an example of a screen to input request information to the system.

FIG. **14** is an example of a screen to input request information to the system.

FIG. **15** is an example of a screen to input request information to the system.

FIG. **16** is an example of a screen to input request information to the system.

FIG. **17** is a flowchart of a lawn mowing work by the autonomous travel work system. FIG. **18** is a diagram to illustrate an approach distance between a tree and the electric lawn mower.

FIG. **19** is a diagram to illustrate the height of the mowed lawn.

DESCRIPTION OF EMBODIMENTS

Hereinafter, the embodiments of the invention will be described with reference to the drawings. FIG. **1** shows a schematic diagram of an autonomous travel work system as an example of the invention. An autonomous travel work system **1** draws an arbitrary design, such as an image and a letter, mowing a lawn in a garden (work ground) LD which is large to some extent or more. The autonomous travel work system **1** includes, in addition to an electric lawn mower (autonomous travel work vehicle) **10**, a computer **100**, a plurality of GPS satellites **120**, and an information terminal **140**.

The electric lawn mower **10**, the computer **100**, and the information terminal **140** are connected to each other through a network **160**.

Although it is not shown in the drawings, the autonomous travel work system **1** may include an operation terminal which can remotely operate the electric lawn mower **10**. The operation terminal may be, for example, a gyro stick which can control a traveling direction and traveling speed of the electric lawn mower **10** by moving the stick right-and-left and back-and-forth, or a device having a button two-dimensionally displayed as an image on a display unit and operated by touching the button with a tough sensor. Furthermore, although it is not shown in the drawings, the autonomous travel work system **1** may include a server which connects to the computer **100** through a network. Various types of data stored in the computer **100** may be stored in the server and the necessary data may be read from the server.

As shown in FIG. **2**, the electric lawn mower **10** includes a mower blade, mower motors **15** (a pair of right and left motors), a rotation sensor **15**S, a travel motor **16** (disposed on both of the right and left wheels), a rotation sensor **16**S, a GPS reception means SE**1**, a location detection means DT, and a communication means SE**2**. The mower blade mows a lawn by rotating. The mower motor **15** rotates the mower blade. The rotation sensor **15**S measures the rotation direction and the rotation number of the mower motor **15**. The travel motor **16** drives a travel tire of the electric lawn mower **10**. The rotation sensor **16**S measures the rotation direction and the rotation number of the travel motor **16**. The GPS reception means SE**1** receives a GPS wave signal from the GPS satellite **120**. The location detection means DT determines the geographical location of the electric lawn mower **10** based on the GPS wave signal received by the GPS reception means SE**1**. The communication means SE**2** communicates between the electric lawn mower **10** and the computer **100**. Furthermore, the electric lawn mower **10** includes a riding/autonomous changeover switch SW**1**, a main switch button SW**2**, a mapping start button MB, a choice button CB, a storage means **17**, a topographic map generation means **18**, and a work pattern correction means **19**. The riding/autonomous changeover switch SW**1** changes the electric lawn mower **10** to be operated when being ridden or when autonomous traveling. The main switch button SW**2** turns ON/OFF of a main power supply of the electric lawn mower **10**. The mapping start button MB performs a mapping by autonomously traveling of the electric lawn mower **10**. The topographic map generation means **18** generates a topographic map by the mapping.

In addition, the electric lawn mower **10** includes a lifting motor DM, a lifting sensor DS, and a motion sensor MS. The lifting motor DM automatically lifts a mower deck (disposed to cover the pair of mower blades) up and down. The lifting sensor DS coupled to the lifting motor DM detects the lifted height. The motion sensor MS measures the three-dimensional inclination of the electric lawn mower **10** with respect to the horizontal surface.

The communication means SE**2** receives a work pattern (described later) and a map data from the computer **100**, and transmits movement information of the electric lawn mower **10** to the computer **100**. The movement information includes the rotation number and the rotation direction of the mower motor **15** measured by the rotation sensor **15**S, the rotation number and the rotation direction of the travel motor **16** measured by the rotation sensor **16**S, the height of the mower deck measured by the lifting sensor DS, and the three-dimensional inclination angle of the electric lawn mower **10** with respect to the horizontal surface measured by the motion sensor MS.

Furthermore, the electric lawn mower **10** includes the work pattern correction means **19** which corrects the work pattern received from the computer **100** based on the map information received from the computer **100** and the topographic map information generated by mapping. The electric lawn mower **10** may include a camera to capture a surrounding situation, although it is not shown in the drawings.

The above described mower motor **15**, rotation sensor **15**S, travel motor **16**, rotation sensor **16**S, GPS reception means SE**1**, communication means SE**2**, location detection unit DT, riding/autonomous changeover switch SW**1**, main switch button SW**2**, mapping start button MB, choice button CB, storage means **17**, topographic map generation means **18**, lifting motor DM, lifting sensor DS, motion sensor MS, and work pattern correction means **19** are connected to a control means **11** and operated under the control of the control means **11**.

As shown in FIG. **3**, the computer **100** includes a control means **101**, a communication means **102**, a storage means **103**, a display means **104**, a user identification means **105**, a work ground designation means **106**, a design allocation means **107**, a mapping route generation means **108**, a work pattern generation means **109**, a work fee calculation means **110**, a schedule management means **111**, a work monitoring means **112**, and a remote operation means **113**. The computer **100** may be movable.

The communication means **102** receives the movement information from the electric lawn mower **10** and transmits the work pattern to the electric lawn mower **10**. In addition, the communication means **102** communicates with the information terminal **140**.

The storage means **103** stores the map information having the location information including the garden LD, a plurality of design images, user information, and work information, which will be described later.

The user identification means **105** identifies the user based on the user information, for example, by preparing a user ID and a password for each user, identifies the user with the user ID and the password.

The work ground designation means **106** generates, based on the map information having the location information including the garden LD and an input border of the work ground, the location information on the border.

The design allocation means **107** generates, based on the map information having the location information including the garden LD and an input design image, the location information about a diagram of the design and contrast information about the diagram on the location.

The mapping route generation means (work information generation means) **108** generates a travel route of the electric lawn mower **10** when the mapping is performed, which will be described later.

The work pattern generation means (work information generation means) **109** calculates, based on the work ground and the design transmitted from the information terminal **140**, the work pattern (the movement route, the location for mowing the lawn, and the height of the mowed lawn) of the electric lawn mower **10** (the detail will be described later).

The work fee calculation means **110** calculates a work fee estimation based on the work information.

The schedule management means **111** determines whether the lawn mowing can be implemented according to a user's desired date and time, and schedules the lawn mowing.

The work monitoring means **112** monitors movement conditions of the electric lawn mower **10** during the autonomous traveling by displaying, on the display means **104**, for example, the current location, the traveling direction, the

traveling speed, the traveling direction, the height of the mower deck, and the rotation speed of the mower blade of the electric lawn mower **10**.

The remote operation means **113** performs a remote operation. The remote operation means **113** can perform various operations (moving forward, moving backward, suspending, turning, lifting the mower deck, and rotating and suspending the mower blade) to the electric lawn mower **10**, and includes an emergency stop button to stop the movement of the electric lawn mower **10** in an emergency.

The communication means **102**, the storage means **103**, the display means **104**, the user identification means **105**, the work ground designation means **106**, the design allocation means **107**, the mapping route generation means **108**, the work pattern generation means **109**, the work fee calculation means **110**, the schedule management means **111**, the work monitoring means **112**, the remote operation means **113** are connected to the control means **101** and operated under the control of the control means **101**.

The GPS satellite **120** transmits the GPS wave signal.

The information terminal **140** is operated by the user (customer) of the autonomous travel work system **1** and communicates with the computer **100**. Although a device capable of being continuously carried with the system user, is preferred for the information terminal **140**, the information terminal **140** may be a terminal capable of connecting with the computer **100** through the network **160**, and may also be a mobile computer, a desktop computer, or the like.

As shown in FIG. **4**, the information terminal **140** includes a control means **141**, a communication means **142**, a storage means **143**, a display means **144**, a user information input means **145**, a work ground input means **146**, a design formation means **147**, a design allocation input means **148**, a desired date/time input means **149**, and a work request means **150**.

The communication means **142** communicates with the computer **100**.

The display means **144** displays image data to input the necessary information for requesting the work, for example, displays an image (e.g., an aerial photograph image) of the map information having the location information including the garden LD, and a design image to be drawn on the garden LD.

The user information input means **145** inputs a user name, the user's address, a credit card number and the expiration date thereof used for settlement by the user.

The work ground input means **146** inputs the border designating the area of the garden LD as the work ground. For example, the display means **144** has input means with a touch sensor, the map image (e.g., an aerial photograph image) having the location information including the garden LD is displayed on the display means **144**, and the user arbitrarily draws the border designating the area of the garden LD as a work ground on the map image with reference to the map image on the display means **144** (the border generated by the work ground input means **146** is displayed on the display means **144** in real time). The border designating the area of the garden LD as the work ground may be drawn by other known drawing method. Alternatively, when the location information about the border of the work ground generated in advance by the computer **100** is stored in the storage means **103**, the work ground may be input by selecting the location information.

The design formation means **147** generates a drawing which is arbitrarily drawn by the user on the display means **144** using the input means included in the display means **144** with a touch sensor (the drawing generated by the design formation means **147** is displayed on the display means **144** in real time). The drawing may be generated by other known drawing method.

The design allocation input means **148** inputs the design to be allocated to the garden LD as the work ground. For example, when the design image is stored in the storage means **103** of the computer **100** in advance, by selecting the design image, the design image is allocated to the garden LD as the work ground, and the design allocated to the garden LD is displayed on the display means **144**.

The desired date/time input means **149** inputs the date and time on which the user desires to perform the lawn mowing as the work.

With the work request means **150**, the user conclusively requests the work. When the work is requested, the settlement may be performed with user's credit card which has been input beforehand, or after the confirmation of the settlement to be performed with user's input credit card and inputting the user's decision of the settlement, the settlement procedure may be performed by a credit company.

The control means **141**, the communication means **142**, the storage means **143**, the display means **144**, the user information input means **145**, the work ground input means **146**, the design formation means **147**, the design allocation input means **148**, the desired date/time input means **149**, and the work request means **150** are connected to the control means **141** and operated under the control of the control means **141**.

The information input or selected by the information terminal **140** is appropriately transmitted to the computer **100** through the network **160** and used by each of the means of the computer **100** or stored in the storage means **103**.

The information terminal **140** may include remote operation means capable of performing a remote operation to the electric lawn mower **10**. remote operation means can perform various operations (moving forward, moving backward, suspending, turning, lifting the mower deck, and rotating and suspending the mower blade) to the electric lawn mower **10** and includes an emergency stop button to stop the movement of the electric lawn mower **10** in an emergency.

A network which enable the electric lawn mower **10** to communicate with the computer **100** and the computer **100** to communicate with the information terminal **140** may be applicable to the network **160**. The network is, for example, a telephone communication network or an internet. A network **160** connecting the electric lawn mower **10** to the computer **100** may be different from a network **160** connecting the computer **100** to the information terminal **140**.

Next, using the autonomous travel work system **1** with this configuration, an example of a work request of drawing a picture on the lawn in a garden LD will be described with reference to FIGS. **1** to **4** and using FIGS. **5** to **16**.

FIG. **5** shows a flowchart of a work request of lawn mowing, and FIGS. **6** to **16** show an example of a screen to input request information to the system.

A user of the autonomous travel work system **1** accesses the computer **100** through the network **160** using the information terminal **140**. The screen data to input necessary information to request a work is transmitted through the network **160**, the input screen is displayed on the display means **144** of the information terminal **140**. In accordance with the displayed instructions on the screen, the user inputs the necessary information to request the work. The input order can be appropriately changed.

First, the user of the autonomous travel work system **1** is identified (S**11**). When user information has not been registered beforehand, user information to identify the user, such

as a user's name and address, a credit card number and expiration date thereof for settlement, is input.

For example, in FIG. **6** showing an example of an input screen, by selecting a button B**2** (member registration), the screen moves to an input screen which is not shown in the drawings, the user information is input. The input user information is stored in the storage means **103** of the computer **100**. A user ID and a password related to the user information are generated by the user identification means **105** of the computer **100** and stored in the storage means **103** of the computer **100**. The generated user ID and password are transmitted to the information terminal **140** and displayed on the display means **144** of the information terminal **140**.

When the user information has been registered beforehand, on the input screen shown in FIG. **6**, by selecting a button B**1** (member login), the screen moves to the input screen shown in FIG. **7** and the user ID and the password are input in input fields IN**1** and IN**2**, respectively. The user is identified by the input user ID and password. On this screen, by selecting a button B**3** (return), the screen moves to the previous input screen. The input screens which will be described later may appropriately include the button B**3** (return). It is only required to identify the user of the autonomous travel work system **1**, and the method for identifying the user is not limited to the above described method.

Next, the garden LD as the work ground where the lawn is mowed is designated (S**12**). A border of the garden LD is input, and based on map information having location information including the garden LD and the input border of the garden LD, the location information about the border is determined.

When the user is identified, the screen moves to the input screen shown in FIG. **8**. By selecting a button B**4** (designate work ground for lawn mowing), the screen moves to the input screen shown in FIG. **9**. The input screen shown in FIG. **8** may include a button B**5** (create new lawn mowing design) by selecting which the screen moves to the input screen to create a new lawn mowing design, which will be described later.

On the input screen shown in FIG. **9**, when the address or a neighborhood address of the garden LD as the work ground is input in a input field IN**3**, as shown in the input screen of FIG. **10**, a map image around the input address based on the map information stored in the storage means **103** of the computer **100** is displayed on SC. The map image may be an aerial photograph image and is not particularly limited. The map image is map information having geographical location information, such as latitude and longitude of a location on the map image. The input screen includes a button BA to enlarge/reduce the displayed map image and may be able to display the map image being rotated.

Next, the border designating the area of the garden LD as the work ground is input. By selecting a button B**6**, as shown in the input screen of FIG. **11**, the border designating the area of the garden LD is input on the map image displayed on SC. By the work ground designation means **106** of the computer **100**, based on the map information having the location information including the garden LD and the input border of the garden LD, the location information about the border is generated and stored in the storage means **103** of the computer **100**. It is only required to designate the garden LD as the work ground for lawn mowing and the method for inputting the border is not limited to the above described method.

The garden LD as the work ground may be designated by selecting one of a plurality of existing work grounds (location information on the borders of the work grounds) stored in the storage means **103** of the computer **100**. For example, on the input screen shown in FIG. **9**, by selecting a button B**7** (to exist candidate location), the screen moves to the screen (not shown) on which thumbnail images of the work grounds stored in the storage means **103** of the computer **100** are displayed and by selecting one of the displayed work grounds, the work ground may be designated. It is only required to designate the garden LD as the work ground for lawn mowing, and the method for designating the work ground is not limited to the above described method.

Next, a design of mowing the lawn in the garden LD (lawn mowing design) is determined (S**13**). To determine the lawn mowing design, there are three methods as follows and any one of the methods may be used. (1) Selecting one of a plurality of existing design data stored in the storage means **103** of the computer **100**. (2) Creating design data from a design which a worker oneself draws with the information terminal **140**. (3) Processing/Creating a design by importing an image data of a photograph, a picture, and the like.

In the method (1), on the input screen shown in FIG. **11**, by selecting a button B**8** (to design screen), the screen moves to the screen to select the method for determining a design as shown in FIG. **12**. By selecting a button B**9** (select from existing lawn mowing design), as shown in the input screen of FIG. **13**, thumbnails images of a plurality of design data stored in the storage means **103** of the computer **100** are displayed. By selecting one of the displayed plurality of design data, the design allocation means **107** of the computer **100** allocates the selected design data to the map image of the work ground, and the allocated image is displayed on SC as shown in FIG. **14**.

In the method (2), on the input screen shown in FIG. **12**, by selecting a button B**10** (create new design), the screen moves to the input screen (not shown) on which the design formation means **147** is operated. Using the design formation means **147**, the user oneself freely draws a diagram, creates design data, transmits the data to the computer **100**, and stores the data in the storage means **103** of the computer **100**. In this case, the input line may be corrected to be a straight line or a curved line by existing correction means. The design may be created on the displayed map image including the garden LD and the user can create a design checking how the lawn is mowed based on the created design.

In the method (3), on the input screen shown in FIG. **12**, by selecting a button B**11** (import design), the screen moves to the screen (not shown) to import the design data, and the image data (design data), such as a photograph and a picture, is stored in the storage means **103** of the computer **100**. Then, similar to (1), by selecting a button B**8** (select from existing designs), the screen moves to the screen on which thumbnail images of the plurality of design data stored in the storage means **103** of the computer **100** are displayed. By selecting one of the displayed plurality of design data, the design allocation means **107** of the computer **100** allocates the selected design data to the map image of the work ground and the allocated image is displayed on SC.

In any methods, the design allocation means **107** allocates the design data to the map image of the work ground, and further generates the location information about the diagram included in the design and the contrast information about the diagram of the design on the location. The generated information is stored in the storage means **103** the computer **100**.

In any methods for determining the design, the design data to be allocated may be allocated after the processes of enlargement, reduction, rotation, correction of contrast, and the like.

Although, the designs are constrained (line width and contrast of the design expressed by the height of the mowed lawn) due to the capability of the electric lawn mower **10**, in any

methods for determining a design, the selected design may be changed to the design based on the constraints of the electric lawn mower **10** by the design allocation means **107** of the computer **100**. Therefore, the user does not need to confirm whether the lawn can be mowed with the selected design, can grasp how the lawn is mowed based on the selected design before the request, and according to which, can decide or change the design.

The method for determining a lawn mowing design is not limited to the above described method. For example, the computer **100** may include design extraction means which is not shown, the design extraction means extracts some recommended designs suitable for a shape of the garden LD and the like from the plurality of design data stored in the storage means **103** of the computer **100** and displays the extracted designs as thumbnails. Then, similar to (1), by selecting one of the displayed plurality of design data, the design may be determined. The design extraction means assists the system user in creating a design and it is possible to reduce the system user's labor for creating a design.

Next, in order to generate topographic map information (mapping) including detail ground shapes (topographic information) of the garden LD, a moving route (mapping route) of the electric lawn mower **10** is generated (S**14**). The mapping route is generated by the mapping route generation means **108** of the computer **100** and stored in the storage means **103**. The mapping route is generated based on the map information stored in the storage means **103** of the computer **100** and the location information about the border of the garden LD, but the method for generating the route is not particularly limited. When the entire of the garden LD can be mapped by the route, the method is not particularly limited. The route is, for example, when the electric lawn mower **10** travels in the garden LD at approximately 2 m intervals.

Next, for mowing the lawn, a work pattern, such as a moving route of the electric lawn mower **10**, a location for lawn mowing, the height of the mowed lawn on the location, is generated (S**15**). The work pattern is generated by the work pattern generation means **109** of the computer **100**. The work pattern is generated based on the map information stored in the storage means **103** of the computer **100**, the location information about the border of the garden LD, the location information about the diagram included in the allocated design to the garden LD, and the contrast information about the diagram of the design on the location. The method for generating the pattern is not particularly limited.

Next, a schedule of a lawn mowing work is managed (S**16**). Whether the lawn mowing is performed or not according to the user's desired date and time for the lawn mowing is determined and the lawn mowing is scheduled. In the schedule management, it is only required to determine the date and time for performing the lawn mowing. The date and time on which the lawn mowing can be performed may be proposed to the user and the user may select from the proposed date and time. The method for managing the schedule is not particularly limited.

After the design is determined, on the input screen shown in FIG. **14**, by selecting a button B**12** (input work date), the screen moves to the input screen to input the work date as shown in FIG. **15**. By inputting the desired date and desired time for lawn mowing in input fields IN**4** and IN**5**, respectively, the schedule management means **111** of the computer **100** determines whether the lawn mowing can be performed on the desired date and time or not. The schedule management means **111** of the computer **100** determines whether the lawn mowing can be performed based on the desired date and time for the work, the work pattern, and the like. When the lawn mowing can be performed on the desired date and time, the desired date and time are stored in the storage means **103** of the computer **100**. When the lawn mowing cannot be performed on the desired date and time, the screen moves to the input screen to input the desired date and time and a notice to input another desired date and time is displayed on the input screen. The method for inputting the desired date and time for the lawn mowing is not particularly limited. For example, dates and times on which the lawn mowing can be performed are displayed as thumbnails and by selecting one of the displayed dates and times, the desired date and time for the lawn mowing may be input.

Next, work fee is calculated (S**17**). The work fee calculation means **110** of the computer **100** calculates the work fee based on the place of the garden LD, the work pattern, the desired date and time for the lawn mowing, and the like. The calculated work fee is stored in the storage means **103** of the computer **100** and is displayed in OU**1** on the input screen as shown in FIG. **16**. The method for calculating the work fee is not particularly limited. For example, the work fee may be calculated based on the size of the garden LD and the traveling route distance of the electric lawn mower **10** when mowing the lawn.

Next, a work request is determined (S**18**). The work request means **150** of the information terminal **140** determines the work request. It is only required to transmit the determination of the user's intention to request the lawn mowing to the computer **100**, the determination of the work request is not particularly limited. On the input screen as shown in FIG. **16**, by selecting a button B**14** (determine order), the determination of the user's intention to request the work according to the information (e.g., the garden LD, the design, the desired date and time for the lawn mowing) as described above is transmitted to the computer **100**, stored in the storage means **103** of the computer **100**, and the work request is determined. When the work is requested, the settlement may be performed with user's credit card which has been input, or after confirmation of the settlement with user's input credit card and inputting the user's decision of the settlement, the settlement procedure may be performed by a credit company.

In the above described example, although the information terminal **140** is used for inputting and displaying various works, the information terminal **140** may include the work ground designation means **106** and the design allocation means **107** which are included in the computer **100**. Furthermore, the storage means **143** of the information terminal **140** may stores the map information, the design data, and the like.

Next, using the autonomous travel work system **1** with this configuration, a method for drawing a picture on the lawn in the garden LD will be described with reference to FIGS. **1** to **4** and using FIGS. **17** to **19**. FIG. **17** shows a flow of the lawn mowing, FIG. **18** is a diagram to illustrate an approach distance between a tree and the electric lawn mower, and FIG. **19** shows the height of the mowed lawn.

First, the map information and the work information is transmitted to the electric lawn mower **10** (S**21**). The work information, such as a mapping route, a work pattern, is stored in the storage means **17** of the electric lawn mower **10**. The electric lawn mower **10** is transferred and placed on the garden LD (S**22**).

By pressing a mapping start button SW**3** included in the electric lawn mower **10**, geographical location information about the electric lawn mower **10** is detected by the location detection means DT (S**23**). More specifically, the GPS reception means SE**1** receives the GPS wave signal from the GPS satellite **120**, and the location detection means DT detects the

geographical location information about the electric lawn mower **10**. Then, the electric lawn mower **10** travels tracing the mapping route, and a laser scanner LS reads the shape of the ground (topographical information) (S**24**). Based on the topographical information read by the laser scanner LS and the location information about the border of the garden LD which has been stored in the storage means **17** of the electric lawn mower **10**, the topographic map information are generated by the topographic map generation means **18** of the electric lawn mower **10** and stored in the storage means **17** (S**25**).

Next, based on the map information which has been stored in the storage means **17** of the electric lawn mower **10** and the topographic map information generated by mapping, the work pattern which has been stored in the storage means **103** of the electric lawn mower **10** is corrected by the work pattern correction means **19** of the electric lawn mower **10** (S**26**).

Next, lawn mowing travel is started according to the corrected work pattern (S**27**). To start lawn mowing travel, a lawn mowing travel start button **159** is pressed. The electric lawn mower **10** starts the lawn mowing travel. The current location and the traveling direction of the electric lawn mower **10** is appropriately corrected based on travel information (e.g., the location information by the GPS satellite **120**, the traveling speed, the traveling direction, and the like). Based on the current location and the traveling direction of the electric lawn mower **10** and the corrected work pattern, the lawn mowing travel (e.g., the traveling speed, the traveling direction, the height of the mower deck, the rotation speed of the mower blade, and the like) is controlled by the control means **11**.

As described above, the lawn mowing is performed according to the desired design on the garden LD. When unexpected dangers, such as an obstacle, are caused during the lawn mowing travel, by an emergency stop button of the remote operation means **113** of the computer **100**, the electric lawn mower **10** can be emergently stopped.

As shown in FIG. **18**, when there is an obstacle, such as a tree TR, in the garden LD, during traveling to map the garden LD, the electric lawn mower **10** needs to avoid the tree TR so as not to collide. In this example, an infrared ray sensor RS provided on a front part of the electric lawn mower **10** projects infrared ray RL forward and detects the reflected infrared ray RL. The infrared ray sensor RS thereby detects the tree TR on the front in the traveling direction of the electric lawn mower **10**. The detection information by the infrared ray sensor RS is transmitted to the control means **11** included in the electric lawn mower **10**. The detection information is, for example, width of the tree TR, the distance between the electric lawn mower **10** and the tree TR.

The control means **11** avoids to travel within a certain distance D from the tree TR by changing the traveling direction and the traveling speed of the electric lawn mower **10** based on the detection information. The location information within a certain distance D from the tree TR is added as a travel avoidance area to the topographic map information generated by mapping, when the work pattern correction means **19** corrects the work pattern, the route may be changed so as not to travel in the travel avoidance area.

As shown in FIG. **19**, average height H of a lawn LW from a ground G is set in advance, and a spot where the lawn LW is mowed height h**2** higher with respect to the average height H, or a spot where the lawn LW is mowed height h**1** lower with respect to a virtual mowed surface AP can be set. With the setting, unevenness of the lawn LW formed on the garden LD is more distinct, it is possible to form a clearer design. These controls are performed the control means **11** of the electric lawn mower **10**.

The work monitoring means **112** of the computer **100** monitors the current location, the traveling direction, the traveling speed, the traveling direction, the height of the mower deck, the rotation speed of the mower blade, and the like of the electric lawn mower **10**. When the electric lawn mower **10** includes a camera to capture a surrounding situation, the work situation may be monitored with the video captured by the camera. Accordingly, the work situation of the electric lawn mower **10** can be monitored with the computer **100** placed away from the garden LD.

In the above described example, the electric lawn mower **10** independently maps the garden LD, generates the topographic map of the garden LD, travels mowing the lawn based on the transmitted map information and the work information (the mapping route, the work pattern, and the like), but various movements may be performed in conjunction with the computer **100**. For example, the computer **100** may include the topographic map generation means **18**, the geographical information read by the laser scanner LS of the electric lawn mower **10** is appropriately transmitted to the computer **100**, and the topographic map information may be generated by the computer **100**. Furthermore, the computer **100** may include the work pattern correction means **19** to correct the work pattern, and correct the work pattern based on the map information and the topographic map information by mapping. In addition, the travel information (the location information by the GPS satellite **120**, the traveling speed, the traveling direction, and the like) of the electric lawn mower **10** during the lawn mowing travel is appropriately transmitted to the computer **100**, and the computer **100** may control the lawn mowing travel of the electric lawn mower **10**.

In the above described example, one of the electric lawn mower **10** performs the lawn mowing work, but a plurality of electric lawn mower **10** may perform the lawn mowing work. By the cooperation and collaboration of the electric lawn mowers **10**, it is possible to divide a lawn mowing area or work procedures, and the lawn mowing work hours can be shortened. It is beneficial especially in a large work ground.

Furthermore, the autonomous travel work system **1** may include a charging station to charge a battery which is not shown in the drawings as a power source of the electric lawn mower **10**. With this configuration, the electric lawn mower **10** can autonomously return to the charging station and charge the battery based on the residual electric power of the battery. After the battery is charged, the electric lawn mower **10** can resume the lawn mowing work. Therefore, it is possible to perform the lawn mowing work without worrying about the residual electric power of the battery and it is not required to be monitored near the work ground to charge the battery and perform the charging work.

In the above described examples, the computer **100** includes the work ground designation means **106**, the design allocation means **107**, the design extraction means, the mapping route generation means **108**, the work pattern generation means **109**, and the work fee calculation means **110**. However, the above means is only necessary to be included in computer **100** or a mobile terminal **140**, not particularly limited. When the mobile terminal **140** includes the above means, the storage means **103** of the computer **100** or the storage means **143** of the mobile terminal **140** stores various types of data (the map information, the design data, and the like) and appropriately using these data, performs determination of the work ground, allocation of the design, extraction of

the design, generation of the mapping route, generation of the work pattern, and calculation the work fee.

In the example, the electric lawn mower **10** is used as a work vehicle, but it is not limited to this. An engine driven lawn mower may be applicable.

Furthermore, the invention is not limited to the above described embodiments, and various embodiments can be made without departing from the spirit of the invention.

INDUSTRIAL APPLICABILITY

The autonomous travel work system of the invention is not limited to the lawn mowing work, and is applicable to various autonomous travel work systems which perform a work, such as drawing an image or a letter on the ground or on ice of a skate link, according to a work pattern formed based on an image and/or a letter regarding a work ground as a canvas.

REFERENCE SIGNS LIST

1 autonomous travel work system
10 electric lawn mower (work vehicle)
100 computer
103 storage means
105 user identification means
106 work ground designation means
107 design allocation means
108 mapping route generation means (work information generation means)
109 work pattern generation means (work information generation means)
110 work fee calculation means
111 schedule management means
112 work monitoring means
120 GPS satellite
140 information terminal
143 storage means
144 display means
145 user information input means
146 work ground input means
147 design formation means
148 design allocation input means
149 desired date/time input means
150 work request means
160 network
LD garden (work ground)

The invention claimed is:

1. An autonomous travel work system which works, regarding a work ground as a canvas and applying an arbitrary design to the work ground, according to the design, the system comprising:

an information terminal configured to be input means and transmit input information;

a computer configured to receive the input information; and

at least one work vehicle configured to work autonomously traveling in the work ground, wherein

the information terminal includes:

display means for displaying a map image including the work ground;

work ground input means for inputting the work ground on the map image displayed on the display unit;

design allocation input means for inputting the arbitrary design to be allocated to the work ground; and

work request means for requesting a work,

the information terminal or the computer includes:

work ground designation means for generating location information about the work ground based on the work ground input on the map image;

design allocation means for allocating the input design to the work ground and generating location information about the design and contrast information about the design; and

work information generation means for generating geographical information about the work ground designated on the map image and the input design as work information.

2. The autonomous travel work system according to claim **1**, wherein the information terminal includes design generation means for creating the design.

3. The autonomous travel work system according to claim **1**, wherein

the information terminal or the computer includes the work fee calculation means for calculating a work fee estimation based on the work information,

the information terminal includes desired date/time input means for inputting a desired date and time for the work, and

the computer includes schedule management means for managing a schedule of the work based on the desired date and time.

4. The autonomous travel work system according to claim **1**, wherein the design allocation means sets the design based on constraint conditions on that the work vehicle is able to work.

5. The autonomous travel work system according to claim **1**, wherein the information terminal or the computer includes design extracting means for extracting a recommended design suitable for a shape of the work ground from existing designs.

6. The autonomous travel work system according to claim **1**, wherein

the information terminal or the computer includes storage means for storing the work information, and

the work request means included in the information terminal requests the work based on the work information.

7. The autonomous travel work system according to claim **1**, wherein the work request means performs settlement of the work fee when the work is requested.

8. The autonomous travel work system according to claim **1**, wherein the computer is movable.

9. The autonomous travel work system according to claim **1**, wherein the work is a grass mowing work.

10. The autonomous travel work system according to claim **1**, wherein the work vehicle electrically travels and works.

11. The autonomous travel work system according to claim **2**, wherein

the information terminal or the computer includes the work fee calculation means for calculating a work fee estimation based on the work information,

the information terminal includes desired date/time input means for inputting a desired date and time for the work, and

the computer includes schedule management means for managing a schedule of the work based on the desired date and time.

12. The autonomous travel work system according to claim 2, wherein the design allocation means sets the design based on constraint conditions on that the work vehicle is able to work.

13. The autonomous travel work system according to claim 3, wherein the design allocation means sets the design based on constraint conditions on that the work vehicle is able to work.

14. The autonomous travel work system according to claim 2, wherein the information terminal or the computer includes design extracting means for extracting a recommended design suitable for a shape of the work ground from existing designs.

15. The autonomous travel work system according to claim 3, wherein the information terminal or the computer includes design extracting means for extracting a recommended design suitable for a shape of the work ground from existing designs.

16. The autonomous travel work system according to claim 4, wherein the information terminal or the computer includes design extracting means for extracting a recommended design suitable for a shape of the work ground from existing designs.

17. The autonomous travel work system according to claim 2, wherein

the information terminal or the computer includes storage means for storing the work information, and

the work request means included in the information terminal requests the work based on the work information.

18. The autonomous travel work system according to claim 3, wherein

the information terminal or the computer includes storage means for storing the work information, and

the work request means included in the information terminal requests the work based on the work information.

19. The autonomous travel work system according to claim 4, wherein

the information terminal or the computer includes storage means for storing the work information, and

the work request means included in the information terminal requests the work based on the work information.

20. The autonomous travel work system according to claim 5, wherein

the information terminal or the computer includes storage means for storing the work information, and

the work request means included in the information terminal requests the work based on the work information.

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